## REMARKS

- Claims 1-4 and 6-8 were previously pending.
- Claim 1 is currently amended.
- Claims 9-20 are new.
- Claims 1-4 and 6-20 are currently pending.

### Claim Rejections Under 35 USC § 103(a)

Claims 1-4 and 6-8 were rejected under 35 USC § 103(a) as being unpatentable over **Haugen** et al., "Simulation of Independent Reservoirs Couple by Global Production and Injection Constraints," in view of **Briens** et al., "Application of Sequential Staging of Tasks to Petroleum Reservoir Modeling," in view of U.S. Patent No. 6,108,608 to **Watts**, "Method of Estimating Properties of a Multi-Component Fluid Using Pseudocomponents," in view of **Scott** "Application of Parallel (MIMD) Computers to Reservoir Simulation."

#### Claims 1 and 2

Claim 1 recites a method of controlling the coupling of multi-platform reservoir and network simulators. Similarly, Claim 2 recites a controller for coupling multi-platform reservoir and network simulators.

Claim 1 defines elements of a method of controlling the coupling of multi-platform reservoir and network simulators that includes:

- providing an open message-passing interface with black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks;

- initiating a first reservoir simulation for one or more physical parameters of a first reservoir in a first reservoir simulator, the first reservoir simulation using a first fluid model;

- initiating a second reservoir simulation for the one or more physical parameters in a second reservoir in a second reservoir simulator, the second reservoir simulation using a second fluid model;

- applying synchronization steps to the advancement through time of the first reservoir simulation executing on a first computing device and the second reservoir simulation executing on a second computing device, each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task;

- translating each of a first hydrocarbon fluid stream of the first reservoir simulation and a second hydrocarbon fluid stream of the second reservoir simulation to a common fluid model of a controller by converting pseudo-components of each of the first hydrocarbon fluid stream and the second hydrocarbon fluid stream

to a super-set of pseudo-components used in the first reservoir simulator and the second reservoir simulator; and

- performing a production operation based on the first reservoir simulation of the first reservoir simulator and the second reservoir simulation of the second reservoir simulator, the first reservoir simulation performed on the first computing device and the second simulation performed on the second computing device using the converted hydrocarbon fluid streams.

Claim 2 defines elements of the controller for coupling multi-platform reservoir and network simulators, including:

- means for interfacing via open message-passing with different types of simulation tasks including black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks;

- means for initiating a first reservoir simulation for one or more physical parameters of a first reservoir in a first reservoir simulator, the first reservoir simulation using a first fluid model;

- means for initiating a second reservoir simulation for the one or more physical parameters in a second reservoir in a second reservoir simulator, the second reservoir simulation using a second fluid model;

- means for applying synchronization steps to the advancement through time of the first reservoir simulation executing on a first computing device and the second reservoir simulation executing on a second computing device, each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task;

- means for translating each of a first hydrocarbon fluid stream of the first reservoir simulation and a second hydrocarbon fluid stream of the second reservoir simulation to a common fluid model of the controller by converting pseudo-components of each of the first hydrocarbon fluid stream and the second hydrocarbon fluid stream to a super-set of pseudo-components used in the first reservoir simulator and the second reservoir simulator; and

- means for performing a production operation based on the first reservoir simulation of the first reservoir simulator and the second reservoir simulation of the second reservoir simulator, the first reservoir simulation performed on the first computing device and the second simulation performed on the second computing device using the converted hydrocarbon fluid streams.

The cited references, Haugen, Briens, Watts, and Scott (referred to by the Office as H, B, W, and S respectively), whether considered alone or in combination, do not appear to teach or suggest an open message-passing interface

adapted to couple reservoir simulation tasks being performed under different simulation models (e.g., black oil models and compositional models). These references also do not appear to teach or suggest a loose coupling scheme in which each simulation task advances independently to synchronization waymarks, taking whatever time steps each simulation task requires.

The Office cites Scott as disclosing "interfacing via open message-passing with different types of simulation tasks including black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks" and "applying synchronization steps to the advancement through time of the first reservoir simulation executing on a first computing device and the second reservoir simulation executing on a second computing device, each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task," admitting that Haugen, Briens, and Watts fail to disclose these features of claims 1 and 2. Office Action (04 May 2010) p. 4. Applicant respectfully disagrees with the assertion that Scott remedies the deficiencies of Haugen, Briens, and Watts.

The newly cited Scott article was published in 1987 and appears to disclose basic fundamentals of "parallel programming" within a single computer architecture, including the early generation parallel processor computer, the Cray X-MP. The article explains that this form of parallel processing was made possible by the introduction of the CREATE statement in ***Fortran*** and the intro of asynchronous variables, which reflects the limited state of the art at the time article was published relative to computing today. See Scott, p. 2. Scott states that "The objective of parallel programming is to find the best way to divide a program into independent parts that can be executed in parallel." Scott, p. 3. Scott goes on to describe that tasks such Newton-Raphson iteration require large amounts of time

for the non-linear, multiphase simulators. See Scott, p.4. Applicant understands the term "multiphase simulators" as used to mean a single simulator that simulates the various phases (ingredients) in a single compositional model (liquid oil, vapor oil, natural gas, water and so forth), and not to include a "first reservoir simulation executing on a first computing device" and a "second reservoir simulation executing on a second computing device," as claimed in claims 1 and 2. Although Scott describes "Forming matrix coefficients for the multiphase case will then be discussed for both the black oil and compositional simulator" (Scott, p. 4), Scott fails to disclose the parallel processing of these of the simulators simultaneously, much less "providing an open message-passing interface with black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks" or "a synchronization step enabling different simulation tasks to take non-identical time steps" as claimed in claims 1 and 2. In Summary, Applicant understands Scott to be a very early discussion of the nuts-and-bolts of HOW TO divide a SINGLE reservoir simulation into independent segments of code and obtain speed by assigning the different segments to different processors.

The Office cites Scott as disclosing "interfacing via open message-passing with different types of simulation tasks including black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks" as recited in claims 1 and 2, stating:

> H, B, and W do not explicitly recite however Scott recites providing an open message-passing interface capable of (The Examiner notes that "capable of" does not represent a patentable limitation since a mere capability is not an explicit limitation. Applicants correction is suggested) communicating with black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks; (Scott. Figure 3, message passing)

Office Action (04 May 2010) p. 4. The Applicant has amended claim 1 for clarification regarding the term "capable of." Regardless, the cited portions of

Scott fail to teach the recited features of claims 1 and 2. Scott describes Figure 3 with regard to a hypercube noting,

> "Two programs must be written to use the hypercube. One resides on the host computer and one or more programs reside on the cube nodes. Figure 3 shows an example of how information is passed between the host and the nodes. In this example, processes 1 and 2 have calculated partial sums and are sending this information back to the host where it is to be totaled." Scott, p 3.

The cited sections of Scott do not disclose a "method of controlling the coupling of multi-platform reservoir and network simulators comprising: **providing an open message-passing interface with black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks**," as claimed in claim 1, or a "controller for coupling multi-platform reservoir and network simulators comprising: means for **interfacing via open message-passing with different types of simulation tasks including black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks**," as claimed in claim 2.

The Office appears to be parsing out the term "message-passing" from the claims and applying a far more basic concept described in Scott with reference to FIG. 3 to reject the claims. However, the term "message-passing" does not appear on its own in the present claims and should be read in context, namely "**providing an open message-passing interface with black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks**," as claimed in claim 1, and "**interfacing via open message-passing with different types of simulation tasks including black oil model reservoir simulations, compositional model reservoir simulations, and different types of**

**surface networks**," as claimed in claim 2. Scott fails to disclose these features or to otherwise remedy the deficiencies of Haugen, Briens, and Watts.

The Office also cites Scott as disclosing "applying synchronization steps to the advancement through time of the first reservoir simulation executing on a first computing device and the second reservoir simulation executing on a second computing device, each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task" as recited in claims 1 and 2, stating:

> H, B, and W do not explicitly recite however Scott recites... each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task; (Scott. Page 4, Forming Matrix Coefficients, including the Newton-Raphson iteration as well as using both black oil and compositional simulators as well as page 2 Parallel computing for the synchronization aspect)

Office Action (04 May 2010) p. 4. The cited portions of Scott fail to teach the recited features of claims 1 and 2. Scott describes the following with regard to forming matrix coefficients:

> "Tasks such as PVT and saturation table look-up's and Newton-Raphson iteration require large amounts of time for the non-linear, multiphase simulators. Therefore, consideration of methods to speedup these tasks by parallel methods is also important." Scott, p. 3.

However, the cited sections of Scott appear to be describing parallel methods used to complete tasks for a single multiphase simulator. Regardless, Scott does not

disclose "applying [or means for applying, (cl. 2)] synchronization steps to the advancement through time of the first reservoir simulation executing on a first computing device and the second reservoir simulation executing on a second computing device, **each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task**" as claimed in claims 1 or 2.

The Office appears to be parsing out the term "Newton iterations" from claims 1 and 2 and applying a far more basic concept described in Scott with to reject the claims. However, the term "Newton iterations" does not appear alone and should be read in context, namely that "each synchronization step enable[es] different simulation tasks to take non-identical time steps, **wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task**" where the first reservoir simulation is utilized for "one or more physical parameters of a first reservoir in a first reservoir simulator, the first reservoir simulation using a first fluid model" and the second reservoir simulation is used for "one or more physical parameters in a second reservoir in a second reservoir simulator, the second reservoir simulation using a second fluid model," as recited in claims 1 and 2. As noted above, the cited sections of Scott appear to be describing parallel methods used to complete tasks for a **<u>single multiphase simulator</u>**; no mention is made of synchronizing steps that enable different simulation tasks to take non-identical time steps or that tasks for **different simulations** advance independently to the next synchronization step.

As Scott does not remedy the admitted deficiencies of Haugen, Briens, and Watts, Applicant respectfully requests that the 35 USC § 103(a) rejections of Claim 1 and Claim 2 be removed and the claims be allowed to issue.

**Claims 3, 4 and 6-8**

Claims 3, 4 and 6-8 include the all the language and limitations of their base claim, Claim 2. Thus, Applicant suggests that since Claim 2 is allowable, Claims 3, 4 and 6-8 are allowable in turn.

**New Claims 9-20**

New Claims 9-13 are added to recite further features of the controller recited in Claim 1. Support for the new claims may be found at least at pages 9-11 of the present application. No new matter has been added.

New claims 14-20 are added to recite further features of a computer readable storage medium in accordance with the disclosure. Support for the new claims may be found at least at pages 9-11 of the present application. No new matter has been added.

**Conclusion**

Applicant submits that the pending Claims 1-4 and 6-20 are in condition for allowance and respectfully requests issuance of the subject application.

Respectfully Submitted,

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